31 (in part) and 32.

Memoirs of the Geological Survey.

EXPLANATORY MEMOIR

TO ACCOMPANY

SHEETS 31 (IN PART) AND 32 OF THE MAPS

OF THE

GEOLOGICAL SURVEY OF IRELAND,

BY

RICHARD G. SYMES, M.A., F.G.S.,

WITH

PALÆONTOLOGICAL NOTES BY THE LATE W. H. BAILY, F.G.S.,

AND

PETROGRAPHICAL NOTES BY J. J. H. TEALL, F.R.S., AND J. S. HYLAND, PH.D.

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CONTENTS.

PREFATORY NOTE.

ONE of the chief features of interest in the area described in the following pages is the remarkable tract of ancient gneiss stretching to the east of Ballyshannon and north of Pettigoe. The real nature of the rocks was not at first perceived, but subsequent examination has shown that they can be readily separated from the ordinary metamorphic rocks of the rest of Donegal. I have myself written the account of them in Chapter III., while the petrographical descriptions of them in that chapter and in the Appendix have been supplied by Mr. J. J. H. Teall, of the Geological Survey of England and Wales.

ARCH. GEIKIE,
Director-General.

GEOLOGICAL SURVEY OFFICE,
25*th April*, 1891.

PREFACE.

THE district here described lies on the south-western border of the great tract of metamorphic rocks which stretches northwards into the highlands of Derry and Donegal. The town of Ballyshannon, situated at the head of Donegal Bay, and on the banks of the River Erne where its waters mingle with those of the Atlantic, marks the apex of a promontory of gneissic rocks bounded on either side by others of Lower Carboniferous age. Strata of Lower Old Red Sandstone enter the district at the extreme south-east (Sheet 32), and terminate along the banks of Lough Erne at Castle Archdall. These beds are here faulted against the Carboniferous Limestone; but where their base emerges near the village of Lack (in Sheet 33), it is seen to consist of massive conglomerate formed of blocks and pebbles of

quartzite, schist, and trap, referable to the metamorphic series to the northwards, and reminding one of the Old Red Conglomerate which runs along the southern borders of the highlands of Scotland. This is undoubtedly an old shingle beach formed along the borders of emergent lands, and probably under the waters of an inland lake. The Old Red Sandstone of Castle Archdall is nowhere visible along the margin of the Carboniferous beds north of Lough Erne, owing to the unconformable overlap of the Carboniferous strata, which rest directly on the gneiss, and were deposited under the waters of a gradually subsiding ocean, which during the stage of the limestone deposits, abounded in corals, crinoids, and mollusca. Some of the Carboniferous strata were also deposited in shallow waters, and in proximity to the land of the period along the northern margin, inasmuch as amongst the hills N. of Lough Eask, near Donegal, all the beds, including the limestones, become conglomeratic, and pass into shingle beds. Such is a brief account of the relations of the rocks described in the present Memoir.

The whole of the Carboniferous part of the district was geologically surveyed by Mr. Symes, the author of this Memoir, except a small portion near Kesh, by Mr. Wilkinson. The Archæan tract was originally surveyed by Mr. Symes and partly by Mr. Mitchell, but has been re-examined by the Director-General and Mr. M'Henry. The Palæontological notes were amongst the last drawn up by the late Mr. Baily for the Survey.

EDWARD HULL,

Director.

EXPLANATORY MEMOIR

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GEOLOGICAL SURVEY OF IRELAND.

CHAPTER I.

Physical Geography.

The district about to be described lies for the most part in the counties Donegal and Fermanagh, but there are small areas of the counties Tyrone, Leitrim, and Sligo also included in it. The district is bounded along the north-west by the estuary of the Eask, which river flows through the town of Donegal, north of the marginal boundary of Sheet 32; on the west the boundary is Donegal Bay; on the south it extends along latitude 54° 28′ from Mullaghmore in the county Sligo to Liscreevin Lough near Castle Archdall. The eastern and northern boundaries correspond to the margins of Sheet 32. The entire area is a little more than 250 square miles in extent.

The only town of importance is Ballyshannon in the county Donegal; and the only villages of note are Pettigoe, Belleek, Bundoran, Ballintra, and Laghy, in Donegal; Kesh in Fermanagh, and Tullaghan in Leitrim.

The physical features of the country to the east of Donegal Bay resemble those on the east side of Clew Bay in the county Mayo. The road running north of Ballyshannon to Laghy through Ballintra winds in a zigzag way along the valleys formed by denudation in the hills of boulder clay. These latter are often two hundred feet high, and of an ovate form (drumlins); the general trend of their major axes being in an east and west direction. Similarly shaped boulder clay hills are met with to the east of Pettigoe and north of Castle Caldwell, as well as in the district between Rosscor House, on the W. shore of Lough Erne, and Bundoran.

South of Oughtdarnid Mountain, which is four miles W. of Lough Derg, the country is wild and barren, being covered with bog and heather, and patches of Drift clay or gravel. Where the rocks are exposed they have bold and rugged features, the flaggy quartzites always presenting a sharp outline.

In the north of the district the ground is hilly, especially to the east and west of Lough Derg. On the E. of the Lough are Grouse Hill, 1,029; Crock Kinnagoe, 1,194; and Tullylinn, 788; and on the W. are Ardmore Hill, 1,086; Oughtadreen, 1,071; Ballykillowen Hill, 826; Croghadalough, 839; and Oughtdarnid, 898. Southwards from these hills the country for a considerable distance presents an undulating surface from three to five hundred

feet above sea level, gradually sloping to the shores of Lough Erne, which is 149 feet above datum level; the only hills in that expanse are Breesy Hill, 855 feet, and Croagh, 624 feet, which stand out in bold relief from the surrounding bog.

On the S. shore of Lough Erne the escarpment locally known as Magho (but marked on the Ordnance Map as "Shean North"), extends in an E. and W. direction for a distance of about six miles, the greatest height being a little over 1,000 feet.

Facing the lake are precipitous cliffs of 500 to 600 feet high, with great accumulations of talus at their base, which form a pleasing feature in conjunction with the waters of the lake. When the outlets from the mountain tarns in the district to the south are insufficient for carrying off the waters, which is very often the case in wet seasons, the excess waters burst through the cavernous limestone of the cliffs, and descend in grand waterfalls to the slopes above the lake. After an excessively inclement season the talus, highly charged with moisture, commences to slide in the direction of the lake, and to encroach on the public road between Belleek and Enniskillen, producing great inconvenience as well as danger to traffic.

Drainage.—The streams in this district either flow into Donegal Bay directly, or through the River Erne in one direction, or into Lough Derg and thence into the River Foyle in the other. The watershed between these drainage-areas enters the sheet north of Oughtadreen Mountain, and passes westwards to the north of Lough Creeve, then southwards by Loughs Golagh and Keeran, between Lough Afue on the north-east, and Lough Naseehoge on the south-west; then by a winding course over Croaghdalough Mountain; thence by Loughs Barderg, Dunragh Beg, Dunragh Middle, and Lough Derg, then south-west to the east of Lough Nagedge, where it becomes the watershed of the rivers which flow into Lough Erne; still continuing in a south-west direction it passes over a hill (881 feet), east of Lough Nabrackmore, and then over the mountain immediately to the north of Lough Rusheen. A little further west it becomes the march of the counties Donegal and Fermanagh, and winds in a north-west direction round Loughs Vearty and Tullynasiddagh; then passing by Lough Cam, and over Breesy Hill, leaves the district at the town of Ballyshannon, on the banks of the River Erne.

The principal rivers which flow into Donegal Bay north of Ballyshannon are the Abbey, the Laghy, and the Ballintra; the latter passing through the richly-wooded demesne of Brownhall, at the Pullaas, remarkable for its caves, cascades, and subterranean stream.

The principal rivers which flow into Lough Erne on its northern shore are the Crassowen, to the north-east of Castle Caldwell; the Waterfoot, about two miles south-west of Pettigoe; the Brannagh, about three miles south-east of Pettigoe; the Termon, which flows through Pettigoe; and the Kesh, which flows through the village of that name.

The only other rivers of any note in the district are the Bradoge, which flows into Donegal Bay at Bundoran, and the Bundrowes,

which separates the county of Leitrim from that of Donegal, and which also flows into Donegal Bay to the west of Bundoran.

Lough Derg is a fine sheet of water in the north of the area under description, about 470 feet above datum level, and although of considerable extent, and close to the watershed of the catchment basin of rivers flowing into Lough Erne, has no catchment basin of any great size of its own. Yet the River Derg, at its north-east corner, has a considerable outfall in a north-east direction. This river joins the River Mourne outside the district, and empties itself into Lough Foyle at Londonderry. Of Lough Derg's wild beauty it is well to quote from the Rev. Henry Newland on "The Erne":—

"Lough Derg has certainly been well chosen as a spot of religious penitence and seclusion, for the character of its scenery harmonises well with such a feeling; it is that of wild and gloomy loneliness. There are no trees to be seen, and very little cultivation of any kind. It is surrounded by heavy round-headed mountains, or gigantic hills, covered with heather, which, with its red stalks and purple blossoms, casts a dull dusky reflexion on the water, and gives to the lake its name. There are few islands besides the Station Island, and these are not without their beauty; but they are still of the same wild, savage character as the coast—rocky, heath-covered, and abounding in myrica and arbutus."

Since the above was written a large tract on the south shore of the Lough has been planted, and at present is well timbered, showing that although arable cultivation is scarce in the district, it would well repay the proprietors if a larger area of this wild country were re-afforested.

Lower Lough Erne, as distinguished from Upper Lough Erne, which is not in this district, presents a very different character from the savage wildness of Lough Derg. Its numerous islands and promontories are well wooded and richly pastured, while the picturesque demesnes of Castle Archdall on the east, and Castle Caldwell on the west, add a rich beauty to the lofty escarpment of Magho, which rises majestically from the south shore.

At Belleek, which is at the extreme west of Lough Erne, and where extensive drainage works, with accompanying massive sluice gates, have just been completed, the lake terminates; and from this point the River Erne, with the concentrated waters of a catchment basin of 1,689 square miles, descends no less than 149 feet in the course of about three miles, urging its rapid course between lofty and thickly-wooded banks, over a rocky bed, to the town of Ballyshannon, where it rolls over the celebrated "Falls of Ballyshannon" into its estuary on the borders of Donegal Bay.

The mountain tarns in the country west of Lough Derg, and extending as far as Belleek, are very numerous, and appear to lie in hollows of boulder clay, with bog extending to the water's edge. Many of these basins have no outlet, especially those in proximity to the watershed, but their drainage may be effected by the spongy morass which connects them with those that have an outfall.

CHAPTER II.

Rock Formations and Divisions.

Name.	—	Sign and Colour on Map.
	Aqueous Rocks	
Recent, . .	Blown sand, ...	Red dots on white ground.
" . .	Bog and alluvium, . . .	Chalons brown and gamboge
Post Pliocene (Drift).	Boulder clay, ...	Engraved dots.
	Sand and gravel, . . .	Engraved dots.
Carboniferous Series.	Yoredale sandstone and shale, .	d^2 Yellow, red dots.
	Upper limestone, . . .	$d^{2'''}$ Deep Prussian blue.
	Middle (or Calp) limestone, .	$d^{2''}$ Dark Indigo.
	Middle (or Calp) sandstone and shale.	$d^{2''}$ Dark Indigo with white dots.
	Lower limestone, . . .	$d^{2'}$ Light Prussian blue.
	Lower Carboniferous shale, .	d^1 Prussian blue and Indian ink.
	Lower Carboniferous sandstone and conglomerate.	d^1 Prussian blue and Indian ink, dotted yellow.
Devonian, .	Lower Old Red Sandstone, .	b^6 Brown.
Archæan Rocks.	Granites, granulites, gneisses, biotite-schists, felspathic eclogites, epidiorites, hornblende-schists.	A
Igneous Rocks,	Dolerite and basalt, . . .	B Burnt carmine.
	Felstone, ...	F Light vermillion.

CHAPTER III.

Archæan Rocks.

From Ballyshannon a tract of moor, rock, and bog stretches eastwards to Lough Erne, and thence northwards as far as a line drawn from near Laghy to Glashagh Bridge (Sheet 24). The area thus defined possesses considerable geological interest, for its rocks present characters so closely resembling those of the more ancient gneisses of the Scottish Highlands, that there can be little doubt in assigning them to the Archæan series. A number of specimens was collected from the following localities to illustrate the chief varieties of these rocks:—

1. Roadside, close to Bannus Lough, 1½ mile W.S.W. from Pettigoe.
2. Side of road, from Pettigoe to Laghy, due west from Drumgun Lough, about a mile N.W. from No. 1 locality.
3. Roadside, immediately west from Glenmore Bridge, on same road.
4. Roadside, immediately south of Mountain Lodge, on same road.
5. The Black Gap, on same road, 1½ mile N.W. from No. 4.
6. Roadside, about a mile N.W. from No. 5.
7. Lough Nadarragh, close to same road, about 2½ miles further west than No. 6
8. Roadside, east of Shinnan Hill, 4 miles E. of Ballintra.
9. Side of road, east of Rath Lough, 4 miles E. of Ballintra.
10. Slope, E. of Carn, 1½ mile N. of Pettigoe.
11. Near cross roads, 2½ miles N. of Pettigoe.
12. At bend of road, 1½ mile west of Lough Alaban, south-east side of Lough Derg.
13. Ferry-house, at end of road, S.E. side of Lough Derg.
14. Right bank of River Erne, western outskirts of Ballyshannon.
15. Half a mile N.E. of Ballyshannon, in stream N. of Camp House.
16. Half a mile W. of Lough Mardal, 5 miles north from Belleek.
17. Roadside, between Columbkille Lough and Lough Aghvog, 2 miles north from Belleek.
18. Carrickacoitin, a mile N.N.W. from Belleek.
19. Roadside, half a mile west of No. 18.
20. Bridge over Crassowen stream, north from Castle Caldwell, on Lough Erne.
21. Roadside, half a mile N.W. from Lough Sallagh, 3½ miles S.E. from Laghy.

22. Roadside, 2 miles S. from Glashagh Bridge, 7 miles N.E. from Pettigoe.
23. Glasha Bridge, 9 miles N.E. from Pettigoe.
24. Roadside, Lough Sallagh, 1 mile E. from Finmore Bridge, 5½ miles E.N.E. from Laghy.

From this collection of specimens a series of thin slices was prepared and submitted to Mr. J. J. H. Teall, of the Geological Survey of England and Wales, for microscopic examination, and he has furnished the following general remarks, and also the detailed notes given in the Appendix.

"The rocks in this collection include :—

Granites and pegmatites.
Granulites or granulitic gneisses.
Coarse-grained gneisses.
Biotite schists.
Felspathic eclogites.
Epidiorites and amphibolites.
Hornblende-schists.

"There are two specimens of typical granite from localities 2 and 18, and two doubtful specimens from 7 and 17. Three specimens of pegmatite occur in the collection (10, 19, and 20). One of these (20) is composed of micro-perthitic microcline, quartz, and a greenish muscovite. One of the typical granites (528),* and one of the doubtful or gneissose granites (537) are described in the detailed report.

"The rocks classed as granulites or granulitic gneisses occur in localities 1, 2, 3, 4, 5, 6, 8, 10, 11, 13, 16, 19, 20, 21. They are fine-grained and usually light-coloured rocks, some of which have the external aspect of granulites. The principal constituents are quartz, microcline, oligoclase, and probably orthoclase. Foliation is defined by muscovite, or biotite, or both, and a parallel banding, due to a variation in the relative proportions of the different constituents, is generally recognisable. Garnet, zircon, apatite, iron-ores, sphene, and epidote occur as accessories. Some of the specimens show folding and the pseudo-current-bedding structure so frequently associated with folding in the crystalline schists. It is evident, therefore, that the rock-masses have been subjected to considerable deformation since the banding was produced.

"The specimen of biotite-schist (553) from 22 is interesting, because it belongs to the same group of rocks as (555) from the adjacent sheet to the north (23). The latter rock contains quartz-lenticles which may represent pebbles. Both rocks, especially the latter, resemble some of the "green schists" from the Southern Highlands of Scotland.

"The two coarse-grained muscovite-biotite-gneisses (545 and 546, from 14 and 15 respectively) resemble many of the granulitic gneisses in composition, but they differ in structure. Field evidence can alone decide as to whether or not they form a part of the same series.

"The rocks classed as epidiorites occur in localities 2, 3, 4, 10. Four of these (529, 530, 540, 534) are described in the Appendix. The specimens which have been examined do not furnish any direct proof that the hornblende is secondary; but the general structure of the rocks, the presence of epidote, and of the quartz-felspar mosaic, point to the conclusion that this is the case. The coarse-grained garnetiferous rock from (19) may or may not belong to the same group as the epidiorites. In the absence of more complete information as to its mode of occurrence, it is safer to describe it as a garnetiferous amphibolite.

* These numbers (527–556) refer to the microscopic slides in the collection of the Geological Survey of Ireland.

"Felspathic eclogites occur at (4 and 12). They are described below under the numbers 533 and 543. Such rocks usually form part of a gneissic complex.

"Hornblende-schists occur at 13, 12, 16, and 18. Descriptions of three specimens belonging to this group are given under the numbers 544, 547, and 549.

"The rocks referred to above are from Sheets 31 and 32. Two specimens are described from Sheet 24—a biotite-schist with quartz-lenticles (555 from 23), and a phyllite-gneiss (556 from 24)." These, however, belong to the ordinary schist, quartzite, and limestone series of Donegal.

Examined on the ground, the rocks which possess the microscopic characters described in the foregoing paragraphs present many of the typical features of the gneiss of the north-west of Scotland. In some places they are tolerably massive, the component minerals being grouped in thick irregular folia, as in parts of the Lewisian gneiss of Sutherland. This, which may be the oldest structure now visible, is a much less schistose arrangement than may be found in many zones and larger areas, where the rock has evidently undergone a subsequent shearing, having thereby become much more schistose, and at the same time more micaceous. The rude foliation is well seen close to certain black rocks (epidiorites, &c.), which are intrusive in the gneiss. The latter certainly possessed this foliation before the intrusion of these dykes.

The general dip of the foliation is towards the N.E. or N., and the rocks consequently present low escarpments towards the S.W. and S. The surface of the ground in many places recalls the curiously mammillated contours of the region of the Lewisian gneiss in the north-west of Scotland. The bosses of gneiss have usually been well glaciated, and appear as somewhat rounded domes rising out of heather and bog.

The Archæan rocks of this area show abundant evidence of having undergone much disturbance subsequent to their older or original foliation. This alteration has been above referred to as conspicuously shown in the microscopic structure of some of them. But it is also strongly marked in the field. An older group of pegmatites may be observed to have been crushed down and drawn out in the direction of foliation, while a newer series, with large pink felspars, sheets of dark mica and much quartz have subsequently been developed, and now traverse some portions of the gneiss in all directions.

Though the parallel banded structure is that usually to be noticed, abundant examples may be observed of puckering and crumpling. As an illustration of this structure, reference may be made to a section exposed on the side of the road half a mile south of Aughtdarnid Hill, nine miles west from Pettigoe. The banded gneiss has there been doubled up and puckered, while the folds have been cut across by still later shearing. This flattening down and shearing of a crumpled structure, which may not infrequently be seen, produces a kind of oblique lamination, that simulates the false-bedding of sandstones.

While the predominant rocks are granulitic or coarse-grained gneisses, passing into micaceous schists where they have been much sheared, they include various intrusive bands or dykes of dark hornblendic rocks not unlike those in the gneiss of the north-west of Scotland. These dykes are usually tolerably massive but show a more or less marked schistosity, which is generally most pronounced along the margins, where they pass into hornblende-schist. They are not infrequent, especially on the north-east side of the Archæan mass on the way to Killeter (Sheet 24). In some cases they are full of pegmatite veins (white felspar, quartz, and mica), while vein-quartz traverses them in the area of shearing towards the boundary with the younger (Dalradian) schists. These dykes are thus younger than the older foliation of the gneiss, but more ancient than the subsequent movements which gave rise to the later foliation.

Between the gneiss and its associated rocks, and the schists, quartzites, and limestones which lie immediately to the north (Sheet 24) and stretch over so great a proportion of the County of Donegal, there is so well-marked a contrast that the geologist has little difficulty in placing them in different sections of the stratigraphical series. While the rocks described in the foregoing pages are clearly to be parallelled with the Lewisian gneiss of Scotland as parts of an ancient Archæan core, the schistose rocks that succeed them to the north are as obviously to be referred to the younger group of phyllites, slates, schists, quartzites and limestones, which, spreading over Donegal and considerable parts of the adjacent counties, pass over into Scotland and form the greater part of the south-western, central and north-eastern Highlands. For this series of rocks the name of "Dalradian" has lately been proposed.* The boundary line between them and the more ancient gneiss in this district lies a little to the north of the area described in the present Memoir, as it runs through the tract of moorland and bog that stretches between Laghy and Killeter (Sheet 24). North of the boundary the rocks are evidently metamorphosed sedimentary strata. They consist of quartzite, dark sericitic mica-schist, phyllite, schistose greywacke and grayish-blue crystalline limestone. They maintain a generally northerly dip away from the Archæan core, but near Killeter they bend round sharply with a southerly strike and an easterly dip, thus following the margin of the older rocks. There appears to have been some intense movement along the line of junction. It is possible that in this zone of shearing some of the bands which abound in flattened ellipses of quartz may represent former conglomerates lying at the base of the younger (Dalradian) schists.

* Anniversary Address to the Geological Society, February 20, 1891, Quart. Jour. Geol. Soc., vol. xlvii., p. 75.

CHAPTER IV.

Lower Old Red Sandstone ("Dingle Beds").

These beds consist of purple and red sandstones, flags and shales, with a conglomerate base. Owing to the large Drift deposits, they are almost entirely hidden; but between the village of Lisnarick and Drumadravy railway bridge, on the roadside, two small outcrops occur; the strata apparently are nearly horizontal, and may be described as red argillaceous sandstones, much broken up. At the boat quay at Castle Archdall a similar rock is seen, but the beds appear to be standing on end, probably owing to a fault which forms the boundary between them and the upper Carboniferous limestone. Immediately under Castle Archdall, at low water, shaley, rotten, red sandstone can be seen on the lough shore. These are the only exposures of these rocks to be seen in this district, but in the next sheet (33) they occur over a large extent of country, and have been described in the Explanatory Memoir to accompany that sheet.

CHAPTER V.

Carboniferous Rocks.

This series is well represented in the district, and is distributed both along the west and south of the great Archæan tract previously described. The boundary along the latter is a line of fault, except near Belleek and Ballyshannon; that along the west being an unconformable overlap interrupted by faults. The series comprises Yoredale shales and sandstones; Upper limestone, generally coarsely crystalline; Middle (or Calp) limestone surmounted by shales, and resting on coarse ferruginous grits and sandstones; Lower limestone, consisting of gray highly crystalline limestone in the upper part, resting on compact limestone, interbedded with dolomite; and Lower Carboniferous sandstone, composed of shales resting on sandstones, grits, and coarse conglomerates. We shall describe the subdivisions in ascending order.

Lower Carboniferous Sandstone.—In the N.E. of the district there is an escarpment near Tullylinn Hill, of very fine sandstone and coarse conglomerate, having a dip to the south at about 10°. Good millstones could be raised here. South of Tullylinn Hill the sandstones are well represented, and consist of coarse sandstone and fine conglomerate, with occasional bands of red and green shales. Where the junction with the gneiss occurs the basal bed is a conglomerate, with pink and white pebbles. Occasional thin bands of dolomite are also met with in this formation. Five miles to the N.E. of Pettigoe, and a little north of the R. C. Chapel, extensive quarries have been worked for a considerable time among the grits and conglomerates, the chief

use of the stone being for circular millstones, and large flags for tombstones; in some of the beds the pebbles are very well rounded, and about the size of a marble.

East of Laghy are black shales, the beds rolling, and much broken up by small faults; and at the base of these shales strata marking a former shore rest on garnetiferous schist, and consist of conglomerate, with angular pieces of mica-schist, and thick-bedded sandstone. Two miles and a half south of Laghy, black highly fossiliferous shales are met with in the brook to the east of Coxtown. Numerous Trilobites were found here. East of the stream section the basement Carboniferous beds in close proximity to the Archæan rocks, consist of ferruginous sandstones and shales, capped by arenaceous flaggy shales, with thin beds of cavernous limestone resting on them.

Lower Limestone.—South of Ballyshannon, and extending as far east as Belleek, are numerous exposures of gray limestone interstratified with brownish-gray dolomite. The bedding of the limestone is generally very regular, with a dip to the south; while that of the dolomites is distinctly irregular, sometimes none being apparent, the rock weathering out in an amorphous honey-combed mass. Good sections are seen everywhere, but more especially in the River Erne, along the northern bank of which the junction with the Archæan rocks can be seen, both in Cliff demesne, and at the factory a little east of Laputa. The basal beds in Cliff consist of conglomerate, with pebbles of vein quartz, resting on highly inclined decomposed gneiss. The conglomerate has a slight dip southwards, and is much jointed, the pebbles being fractured in a direct line.

Referring to the dolomite of Ballyshannon, the late Professor Apjohn writes :—*

"As many limestones contain a small quantity of magnesia, their conversion into dolomites may sometimes be accomplished, not by the addition to them of magnesia, but by the removal of carbonate of lime effected by the solvent action of water impregnated with free carbonic acid."

A mile to the north of Ballyshannon are great crags of gray crystalline limestone, more or less horizontal; these are probably the uppermost beds of the series, and have adjoining them the sandstones of the "Calp" series, almost in conjunction; consequently there must be a fault with a considerable downthrow on the north, by which the shales of the latter series have been thrown down and concealed.

To the N.E. of Ballyshannon, the road to Ballintra traverses a district for the most part devoid of drift, and numerous crags of gray crystalline limestone are seen over 100 feet above the plain. At Lurgan Lower, which is on the W. side of the road just alluded to, the highest beds of the series are met with, and these dip

* On the analyses of Irish Dolomites, by James Apjohn, M.D.—Jour. Geo. Soc., Dub. Vol. I., pt. IV., p. 368, et seq.

steadily under the "Calp" shales, near Rossnowlagh Church. The further east we go, we descend in the series, and the beds are not so crystalline, but become cherty, with occasional patches of dolomite.

About the Abbey, which is a quarter of a mile N.W. of Ballyshannon, the lower beds of the Lower Limestone, consisting of dolomite and gray limestone, are brought up against the shales of the "Calp" by a fault, and the latter series farther westward is brought up by another fault against sandstone of the same division. The dip of the gray limestone is very irregular, owing to numerous dislocations.

In Brownhall demesne, which lies about a mile to the east of Ballintra, the gray cherty limestones are cavernous, and the Ballintra river rises and sinks among them at the Pullaas. East of Brownhall, the limestones become associated with shales and arenaceous beds, and as one approaches their junction with the gneissic series, conglomerate and flaggy white sandstone occur frequently.

S.E. of Brownhall, bosses of dolomite are frequent in the low ground. Near Coxtown, which is a mile and a half N. of Ballintra, the boundary has been drawn between the Lower Limestone and the Lower Carboniferous Shale. The limestones are generally gray, thick-bedded, passing downwards into black, laminated shaly limestone, sometimes cherty. Three miles S.E. of Ballintra, the country is very similar to that adjoining Ballintra; numerous crags are seen of gray crystalline limestone, with occasional beds of dolomite interstratified, and having a general dip to the south. About Ballintra, exposures of limestone, devoid of drift, cover a considerable area. South of the village, crags of gray crystalline limestone dip S. at low angles, while around the village the limestones are unevenly bedded and are interstratified with shales, along the strike of which the Ballintra river cuts its course. Beds of evenly bedded cherty limestone of considerable thickness occur S.S.W. of Laghy; they are each about a foot thick, and dip W. as high as 10°.

In the Moyne river, two miles N.E. of Laghy, there is a continuous section of blue and gray fossiliferous flaggy limestone, sometimes cavernous, with shale partings, dipping W. and N.W., at angles varying up to 25°. East of this section is a great accumulation of boulder clay, which completely covers the country for a considerable distance, so that the relation between these limestones and the gneiss to the east cannot be accurately determined. In the neighbourhood of Belleek, and especially in the River Erne, the dolomites predominate over the ordinary limestones, and appear to be in the higher beds of the Lower Limestone, as well as in the lower. An E. and W. fault running through Belleek, with an upthrow on the north, would account for their proximity to the shales of the "Calp" type, but there was no fault apparent in the well-exposed section about Belleek Bridge.

East of Belleek, and extending as far as Bleanalung Bay on Lough Erne, limestones and dolomites crop out over the whole

area, and their junction with the schistose rocks may frequently be observed, especially about Loughs Keenaghan and Scolbaun. Their bedding is to a certain extent regular, but in places, such as in the vicinity of the loughs before mentioned, it is slightly displaced by small dislocations. Among the limestones south of Castle Caldwell Church, there occurs a band about eight inches thick, composed almost entirely of crinoidal stems, some of them being of a bright salmon colour, while others are quite white. East of Keenaghan Lough, three outliers of dolomite were noted in troughs in the old gneiss.

Four miles N.E. of Pettigoe, and to the south of the Termon river, there are large exposures of unevenly bedded limestones and shales with a steady dip to the south and south east at angles as high as 20°. The same strata appear in the river to the north of Pettigoe much disarranged by small faults. The river section in the town of Pettigoe lays open thick bedded limestones with shale partings very much broken up by small faults, and dipping at various angles eastward. A mile S.W. of Pettigoe, in the railway cutting, are thin limestones and shales with a steady strike for some distance, the dip being to the S.E. at angles as high as 20°. A little N. of this the road section shows alternations of dolomite and thin limestones with a high dip; the latter probably due to their proximity to the large fault, by which the Carboniferous rocks are brought against the Archæan series. The boundary between the Lower Limestone and the Lower Carboniferous Sandstone north of Pettigoe is not very clearly defined, as the sandstones, shales, dolomites, and limestones, alternate and dovetail into one another; but south of the Termon river the Lower Limestone series consists exclusively of thick-bedded blue and gray limestones, and is devoid of dolomitic beds.

In the railway cutting three miles S.W. of Pettigoe, and on the shore of Lough Erne, the limestones become arenaceous, and are interbedded with shales. In the Waterfoot river, which flows into Lough Erne south of Pettigoe, the section shows thick-bedded blue limestones, much broken up and disturbed by small faults.

To the north of Bundoran, at Aughrus Point, the boundary between the lower limestone and the "Calp" shales is well defined. The limestones are highly fossiliferous, especially about the Fairies Bridge. Some of the beds near the point have numerous veins of calcite; the general dip is to the south, curving gradually round to the S.W. direction.

Middle (or Calp) Limestone, Shale, and Sandstone.—This division consists of three members: the upper consisting of dark earthy and carbonaceous limestone and shales; the middle, of ferruginous sandstones; and the lower, of black fossiliferous shales. The presence of these beds to the north-west of Ballyshannon is clearly indicated by good coast sections from Coolmore on the north to Kildoney Point on the south. The lowest beds there consist of shale and impure limestone, full of fossils; and as one ascends in the series the shales canbe seen in the cliff near Leckpeggy, to dovetail into obliquely laminated sandstone, which is capped by evenly

bedded flaggy fossiliferous sandstone. In proportion as we rise in the section the sandstone becomes coarser, until, at Kildoney, the beds are conglomeratic.

The general dip of these strata is to the south, but in places there are small dislocations which alter the dip. The sandstone of this division has proved a good building stone, and quarries of white sandstone have been opened at Cool Beg and Cashel Upper. Interstratified with these white sandstones are some beds utterly worthless for building purposes, owing to the large quantity of crystals of iron pyrites they contain. Along the estuary of the River Erne, west of Ballyshannon, fossiliferous shale and sandstone are well exposed along the northern shore, dipping to the south at low angles. A fault boundary, referred to hereafter, separates them east of Wardtown, with a downthrow to the east.

Extensive engineering works have been carried out in the River Erne, east of Belleek, and a channel has been cut in the shales, at least twelve feet deep, as far as Rosscor Point, three miles east of Belleek, to relieve the surcharged water of both Upper and Lower Lough Erne. The shales in this section were difficult to quarry, and the output has been placed in spoil banks extending for hundreds of yards along the river bank; a few years of exposure to the atmosphere have disintegrated the entire mass.

At Castle Caldwell are two promontories extending in a N.E. direction into the lough. The northerly one is composed of shales and impure limestone with silicified fossils, having a dip of about 5° to the south; while the southern one has a continued outcrop of ferruginous and slightly calcareous sandstones, with a steady dip to the S. and S.E. at angles as high as 20°.

East and north-west of Pettigoe the ground is covered with thick accumulations of bog and drift, yet numerous exposures are met with of both the shales and sandstones. The sandstones occupy a considerable area, and from the steady dip to the south, at angles varying from 5° to 20°, it has been assumed that there must be parallel faults along the strike of the beds producing a repetition of the strata.

In Boa Island, which is one of the largest in Lough Erne, as well as in the islands adjoining, the sandstones are well represented, and must be of a considerable thickness, as a steady dip is maintained. Between Boa Island and the north shore the shales of this series are not exposed, and are probably either cut out by a fault, or if they do exist under the drift in Inishkeeragh, they must lie at high angles.

North of the village of Bundoran, at Aughrus Point, the boundary between the Lower Limestone and the Calp series is seen. The beds of the latter consist of fossiliferous shales, with a few bands of impure limestone in them, and have a steady dip S. and S.S.W. at about 20°. West of Bundoran the shore section lays bare the shales, amongst which, to the west of Rochfort Lodge, there is a bed of limestone three feet thick, which is burned for hydraulic lime. Another bed similar in character, and probably continuous therewith, is met with in the top of the cliff at Dane

Ville Lodge. South of Bundoran good sections of the sandstones are seen in the Rock of Bundoran, where grits and ferruginous sandstone dip south at low angles.

At Bundrowes Bridge, one mile and a half west of Bundoran, the boundary is seen of the sandstones and lower shales, and a good coast section of the sandstones can be observed for about two miles west of the bridge. The general dip for some distance is to the north and abnormal; among these sandstones, about a quarter of a mile west of Tynte Lodge, is a sheet of blue limestone eighteen inches thick.

In the escarpment south of Lough Erne, which is locally called Magho, the sandstones are concealed by an enormous accumulation of shingle, but the upper shales and impure limestones are well exposed in the inaccessible cliff, and are capped by the upper limestone, forming the crest of the scarp. Westward from this escarpment the sandstones are met with in the low ground on the shore of the lough, near Slawin Church, where they are much disturbed by a fault which gives the beds an abnormal dip to the north.

On the shore at the extreme N.W. of the district shales much faulted dip every way at angles as high as 10°. Among them was noticed a band of limestone with small angular pieces of quartz, which gradually passes into a conglomerate.

In the quarry north of Laghy, there are about sixty feet of a vertical cliff of flaggy and cherty limestone, the chert being in the centre of the flags. Some beds could be raised a hundred square feet in size, and the flags range from two to ten inches thick, separated from one another by thin shale partings. The lowest beds are most suitable for raising, as they have but few joints.

Upper Limestone.—Along the southern margin of the district, and to the south of Lough Erne, the beds of this division occur on the top of the cliffs which form the Magho escarpment, about 900 feet above the surface of the Lough. The rock is probably not more than 200 feet thick altogether, and consists of thick beds of bluish cherty and coralline limestone which have a steady dip of about 5° to the south, and the strike is continuous along the high ground. Microscopic sections show that the chert is largely formed of spicules of sponges and other siliceous organisms.

In the stream running by the Kesh and Ederny Road, beds of blue crystalline limestone form the channel of the stream, and dip steadily in a southerly direction at an average of 5°. At the village of Kesh large openings occur in beds of fossiliferous limestone, with a few of shale, dipping south at 5° to 10°. On the shores of Kesh Bay, opposite Rabbit Island, blue limestone, with shale partings and highly fossiliferous, crops out from under the Drift clay; these beds have a great resemblance to Calp limestone. At Drumbane Mill there is but little Drift, and the rock is close to the surface, and several large quarries have been opened; the beds roll slightly, with an average dip of about 5° in a southerly direction. They consist of blue crystalline

cherty limestone, containing fossils. To the north of the fault, which forms the boundary between the Lower old Red Sandstone and Upper Limestone, a narrow strip of limestone is seen dipping at a high angle (55°) under the Yoredale sandstone; it is a hard blue, much weathered limestone, with a little chert. The beds in this locality have been disturbed by faults mentioned in the Memoir of Sheet 33.

Yoredale Sandstones constitute the highest of the Carboniferous series in the district. They are well shown on the shores of Lough Erne. Cleenishgarve Island is formed by a ridge of massive, evenly bedded, yellow sandstone, dipping due S. at 10°.

The same beds form the rocky points of Gubbaroe and Ardatrave, and on the higher ground of Clareview and Dromard. Yellow and brown sandstones crop out from under the drift; at the latter place they have a very great resemblance to the "Calp" sandstone, north of the Glenade Valley.

CHAPTER VI.

Igneous Rocks.

Dykes and small bosses of dolerite, probably of Tertiary age, are not unfrequent in the area under description, more especially amongst the Carboniferous rocks.

At Raneany East, one mile N.N.E. of the village of Laghy, there is a dyke of very hard dolerite, sixteen feet wide, bursting up through the black shaly limestone, which is much broken and disturbed at the junction. The shales at the side of the cottage, on the west side of the dyke, have that peculiar parallel jointing which has been frequently observed along similar intrusions in the Co. Sligo, especially about Enniscrone, west of Ballina. This intrusive mass may be the continuation of the dolerite dyke half a mile south-east of this place, as well as the dyke two miles north-west, and just outside the limits of the district. In the bed of the stream, south of this, one would expect to meet its continuation, but instead, there are shaly limestones with a high quaquaversal dip, as if the shales had been subjected to an upthrust from beneath by an intruded mass.

In the stream, north-east of Laghy, there is a small dyke of felstone which runs in a N.N.W. direction, and which changes the shales into hornstone. A short distance north-west of the same village, a twelve foot dyke, running N.N.W., is shown in the stream on the east side of the bridge.

A mass of decomposed dolerite is seen to protrude at a mile and a half south of Laghy, close to Ballynakilla Lough, which indurates the limestones on the north side, and converts the fossiliferous shales on the south into hornstone. The decomposed dolerite is used as gravel for road-mending, also as a highly

fertilizing agent in the limestone districts. To the north-east of Laghy a dyke is met with, on the north of the road, of massive undecomposed dolerite, running in a N.N.W. direction.

A mile and a half south-east of Laghy, two small dykes of basalt, running north and south, are met with in the quartzites.

In the Ballintra River, east and west of the village, are small dykes of disintegrated basalt, which follow the strike of the limestones, with parallel jointing, for some distance along the walls.

Three miles south-east of Ballintra, on the west side of Golagh Lough, are two narrow dykes of dolerite which run in a north-west direction along the natural boundary between the Lower Limestones and the Metamorphic series. Other dykes occur near Ballintra and Brownhill.

At the extreme point of the northern promontory at Castle Caldwell is a massive dolerite, enclosing quartz fragments, which extends across the strike of the beds, and acts as a kind of breakwater. East of this dyke there is a small fault, and thin squirts of the dolerite were traced in the shales adjacent to it.

Four miles north-east of Pettigoe, and south of the Termon River, are numerous small dykes of basalt or dolerite among the limestones, some of them being prolonged into the Calp sandstones to the south; other dykes of similar rock occur further north, and are shown on the map. At about two miles north of Pettigoe are several basalt dykes, the largest of which is fifteen feet across.

In the Waterfoot River, a mile and a half south of Pettigoe, is a dyke of compact bluish-black felstone which breaks with a conchoidal fracture; and in the Termon River, half a mile south of Pettigoe, there are four large parallel dykes of dolerite which run in a north-west and south-east direction, and disturb the limestones in contact with them.

Five miles south-west of Pettigoe, on the shore of Lough Erne, there is a dyke of dolerite running in a north-west and south-east direction: this protrusion is remarkable in that it contains numerous angular pieces of quartzite, and its extension can be traced in the high ground south of Lough Erne, and about 400 feet above the lough, with similar characteristics Further south it is still to be met with, and has already been alluded to in the Memoir to accompany Sheet 44 (page 16). In the railway cutting, three miles south-west of Pettigoe, a dyke of highly crystalline dolerite, forty feet wide, is laid open, containing numerous zeolites, and it can be traced on the south shore of Boa Island, where it is twenty feet across.

CHAPTER VII.

Post Pliocene or Drift Deposits.

Boulder Clay.—The Drift accumulations are composed exclusively of boulder clay, consisting of stiff blue or reddish clay enclosing striated blocks of rock; no beds of sand or gravel were observed. On the N.W. of the district the boulder clay is very

thick, containing almost exclusively limestone blocks, and the outline of the hills formed of this material present a rounded form.

To the east of Laghy, where the Lower Carboniferous beds outcrop close to the Archæan series, the Drift deposits partake largely of the underlying materials. To the east they are composed of *débris* of the more ancient rocks, with a sterile covering of bog and heather; while to the west they consist almost entirely of limestone blocks, with a few fragments of Lower Carboniferous sandstone. This latter kind of Drift has a rich and thick soil on top. Above the village of Laghy a section shows the boulder clay hills to rise about two hundred and fifty feet above the bed of the brook. The bed of the stream is formed of oblong blocks and rounded pebbles of garnetiferous schist, and other rocks brought down from the east; whereas the boulder clay hills through which the river cuts its course are made up of clay with limestone blocks and fragments of the local rocks.

About Ballintra the Drift is very patchy, and occurs in drumlins with an E. and W. trend; some of these, although of small area, have a considerable thickness of boulder clay in them, and stand out in isolated patches on a floor of gray limestone or dolomite.

East of Pettigoe there are large accumulations of boulder clay, composed almost entirely of blocks of sandstones, shales, and impure limestones of the "Calp" series. South of Lough Erne, and extending westwards as far as Bundoran, the boulder clay hills are capped with impervious brick clays, and these in turn are covered by a poor marshy soil.

Erratics.—Large boulders are frequent, the most conspicuous being of granite, which must have been transported a considerable distance. One of these boulders occurs North of Ballintra R.C. Chapel, consisting of pink orthoclase granite, with but little mica; this block is in shape oblong, and may weigh about 25 tons.* To the S.W. of the village of Ballintra are numerous small blocks of granite on the boulder clay. A mile and a half north of Ballyshannon, and a little to the east of Ballynaclagh hamlet, a large well-rounded granite boulder was observed. South of the protrusion of dolerite, at Ballynakillen Lough, about a mile south of Laghy, are numerous granite erratics in the stream, and others occur abundantly on the shore of the estuary at the N.W. of the district. They were probably brought down the valley of the River Eask from Barnesmore Mountain, which is in the district north of Sheet 32. In the country east of Laghy are numerous erratics of the Archæan rocks of the district, and to the S.S.W. of Laghy a perched block of dolerite rests on blue limestone.

In Cavangarden demesne, two miles N.E. of Ballyshannon, a large erratic of gneiss was observed resting on boulder clay.

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* This description applies to the granite of Barnesmore, about ten miles to the north of this locality.—E. H.

CHAPTER VIII.

Recent Accumulations.

Bog and Alluvium.—The high ground in the centre of the district is covered with extensive and thick peat which extends also over the hill tops in almost unbroken sheets and fills up, often to a depth of over twenty feet, the deep troughs which exist between the several outcrops of the Archæan rocks. To the west of Ballintra are extensive alluvial flats composed of beds of loam, clay, and gravel, which extend to Donegal Bay: these have been partially reclaimed, and protected from the encroachment of the sea by embankments thrown up on the seaboard, as well as on either side of the drains and rivers which traverse them.

Blown Sand.—Long high undulating hills of fine sand, with sharp crests on the sea face, protect the estuary of the River Erne in the S.W. of the district, and a low ridge extending for over two miles in a northerly direction acts as a breakwater to the estuary of the River Eask. A similar ridge also forms the Barr of Bunlin, and protects the alluvial flats W. of Ballintra. Bones and horns of *Cervus megaceros* were found in the sand dunes W. of Ballyshannon. No other traces of pre-historic remains were noted.

CHAPTER IX.

Principal Faults.

Faults are numerous, though often of small extent. The most extensive of those observed is one ranging E. and W. on the east of the district, N. of Castle Archdall, whereby the whole of the Lower Carboniferous series is thrown down on the north considerably over a thousand feet, and the Yoredale Sandstone and Upper Limestone are placed in conjunction with the Lower Old Red Sandstone.

North-west of Ballyshannon a fault running in a N.E. and S.W. direction brings the uppermost beds of the Lower Limestone against the sandstones of the "Calp". division, by which the shales of that series are cut out altogether: this fault also affects the shales of the "Calp" east of Wardtown, which are brought up on the same horizon along the estuary of the River Erne.

North of Ballyshannon numerous dislocations occur among the Lower Limestone: the principal one is in an easterly and westerly direction, the limestones on the north being thrown

down against the gneiss on the south from Rath Lough westwards. The small faults south of Ballyshannon, and along the northern banks of the River Erne, do not affect the geology of the district to any appreciable extent.

North of Ballintra an east and west fault has been traced, by which the Lower Limestone is thrown down on the south against the Lower Carboniferous sandstone on the north.

North of Brownhall an east and west fault, which is traceable for a considerable distance, throws down the Lower Limestone and rocks of the Archæan series against the Lower Carboniferous sandstones on the north.

East of Pettigoe two parallel faults have been traced in the Calp sandstones, owing to which the latter, with their steady dip, occupy a much larger area than would otherwise be the case.

The large fault west of Pettigoe, by which the Carboniferous beds are brought down against the Archæan rocks, has already been referred to. It ranges in a north-easterly direction from the shores of Ross Harbour Bay, an inlet of Lough Erne, to the eastern slopes of Grouse Hall Hill. In consequence of this fault the Lower Carboniferous sandstones are cut out altogether throughout the greater extent of its course.

East of Belleek, in the neighbourhood of Loughs Scolbaun and Keenaghan, numerous small faults are visible, but the geology of the locality is little affected by them.

To the north of Bundoran, somewhere in the Tullan Strand, there must be a considerable east and west fault, with a downthrow to the north, by which the sandstones of the Calp series have been thrown down on the north, and the Lower Limestone brought up on the south.

CHAPTER X.

Minerals.

The minerals discovered in this district are of very little importance, and although several trials have been made, the results have never justified the expenses incurred. Copper pyrites, as well as malachite in small quantities, was noted in the dolomite at Keenaghan Lough, east of Belleek, and adjoining the small faults. In the same locality ore, resembling bog-iron ore, was extracted out of pockets in the fault rock south-west of Scolbaun Lough. Similar ore was worked in the fault rock which marks the boundary between the Carboniferous and Archæan series about four miles south-east of Ballintra, as well as in the Black Cat Cave north-west of Belleek.

South of Castle Caldwell Church red hematite was found in several places in amorphous gray limestone; also from the boulder clay of that locality several nodules were extracted.

At the abbey, north of Ballyshannon, sulphate of baryta was formerly worked; and in the gray limestones south of the blown sand, two miles west of Ballyshannon, numerous small veins of this mineral were noticed.

A vein of galena, two inches thick, was worked in the townland of Ballymagrorty, a mile and a half S.S.E. of Ballintra; and in the adjoining farms nodules of a rich lead ore are frequently met with in the soil and subsoil.

CHAPTER XI.

Glaciation

In the N.E. of the district the general glaciation is towards the S.W. as far as Pettigoe, where probably it was deflected more to the west by a large mass of ice which came along the basin of Lough Erne from the east, and passed over the country to Donegal Bay in a direction generally a few degrees north of west.

Glacial Striæ observed in this District.

Six-inch Map.	Townland.	Position.	Striæ.
Donegal.			
100	Cormull, . . .	S. of Golagh Lough, . . .	E. and W.
"	Shannagh, . .	W. of N. and S. fault, . .	E. and W.
103	Ballymagrorty, Scotch,	W. of Cross roads, . . .	E. and W.
"	Ballynacarrick, . .	S.E. of Ballynacarrick hill, . .	E. and W.
104	Shannagh, . .	S.E. of Shannagh bridge, . .	E. and W. N. 40 W.
"	Ballymacarrick, .	On sandstones adjoining gneiss, .	E. and W.
106	Kildoney, . . .	N. of Kildoney point, . . .	E. and W.
107	Town Parks, . .	S. of Abbey bay, . . .	N. 80 W.
"	Finner, . . .	In railway cutting, . . .	E. and W.
"	Carrickboy, . .	Do., . . .	N. 70 W.
"	Cherrymount, . .	Do., . .	N. 70 E. N. 80 W.
108	Cloghore, . . .	Do., . . .	N. 80 W.
"	Derrykillew, . .	On gneiss, one mile N.E. of Belleek.	N. 80 W.
109	Ardfarn, . . .	On Rock of Bundoran, . .	E. and W.
"	" . . .	S. of Rock of Bundoran, . .	N. 80 E.
Fermanagh.			
1	Montiaghroe, . .	E. of Cross roads, . . .	N. 45 E.
"	Aghavore,	N. of Luranboy bridge, . .	N. 37 E.
4	Rossharbour, . .	In railway cutting, . .	N. 65 E. N. 65 W.
"	Tullyvocady, . .	On gneiss, ...	N. 75 E.
"	Bigwood, . . .	On lake shore, ...	N. 70 E.
"	Aghnablane, . .	In railway cutting, . . .	E. and W.
"	Letter, . . .	On lake shore, ...	N. 75 E.
"	Lustybeg Island, .	Do., ...	E. and W.
5	Aghalain, . . .	In railway cutting, . . .	N. 50 E.
"	Clonelly, . . .	In stream, ...	N. 45 E.

APPENDIX.

I. Palæontological Notes to Sheets 31 and 32.

Localities from which Fossils were collected.

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
			Sheet 30.
		Co. of Donegal.	Carboniferous Limestone, Shale, and Sandstone.
1	26/4	Muckross, . .	Rocks on shore, at Muckross Point, about seven miles south-west of Killybegs; lower limestone, dark gray shale.
1A	97/1	Shalwy, . .	Rocks on shore, at Shalwy Point, west side of Fintragh Bay; dark gray limestone and shale, lower limestone shale.
1B	97/1	Largysillagh, . .	Rocks on shore, half a mile north-east of Rinn Point; dark gray sandstone, lower carboniferous.
2	97/1	Do., . .	Rocks on shore, at Fintragh Bay, two and a half miles south-west of Killybegs; dark gray sandstone, lower carboniferous.
3	97/4	Killultan and Point,	Rocks at various places on the sea shore of the peninsula leading to St. John's Point; dark gray limestone and shale, lower limestone shale.
3A	98/1	Bruckless & Dorney,	Rocks on shore, at Bruckless Harbour, M'Swyney Bay, one and a half miles west of Dunkineely, sandstone, shale, and conglomerate, lower carboniferous.
4	98/1	Ballymagowan and Brenter.	Rocks in stream, a little north of Bunlack's Bridge, one mile east of Dunkineely; dark gray micaceous shale, lower carboniferous.
5	98/4	Point, . .	Rocks at Waterfall, a little west of Murles Point, four and a half miles south-west of Mount Charles, eight miles north-west of Ballyshannon; dark gray micaceous shales; lower limestone shale.
6	98/4	Raneely, . .	Rocks on shore, at Dorrin Point, Inver Bay, five miles south-west of Mount Charles, eight miles north-west of Ballyshannon; dark gray micaceous shale, lower limestone shale.
7	99/2	Summerhill, . .	Rocks on shore, east side of Ball Hill, a little south of Old Castle, two miles south-west of Donegal; dark gray shales, lower limestone shale.
8	99/4	Rossilly, . .	Rocks on sea-shore, at Rossillybeg, eight miles north-east of Ballyshannon, two and a half miles north-west of Ballintra; dark gray limestone and shales, lower limestone shale.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
9	103/2	Lacklone, . .	Quarry at side of road, a little south of Drummacroil Cottage, one mile north-west of Ballintra, six miles north-east of Ballyshannon; dark gray limestone.
10	103/2	Killenagh, Lower, .	Rocks close to Foyagh Bridge, four and a half miles north of Ballyshannon; dark gray shale, lower limestone shale.
11	103/2	Ballymagrorty, Scotch.	Rocks in small stream, about three quarters of a mile south-west of Ballintra, a little north of Old Castle, five miles north-east of Ballyshannon; compact dark gray limestone.
12	103/2	Ardnagalliagh, .	Quarry at Connor's Bridge, five and a half miles north-east of Ballyshannon; dark gray limestone and shale.
13	103/2	Ballymagrorty, Scotch.	Quarry west side of road from Ballyshannon to Ballintra, quarter of a mile south of Ballintra Bridge, and five and three quarter miles north-east of Ballyshannon.
14	103/3	Rossnowlagh, Upper,	Rocks in stream, about quarter of a mile south of Tullyreaghan Church, close to school, about three quarters of a mile north of Ballyshannon; dark gray shale, lower limestone shale.
15	103/4	Ardpattan, . .	Rocks a little south-west of Ardpattan Lough, two and three quarter miles north-east of Ballyshannon; dark gray limestone.
16	103/4	Alla or Cashel, .	Rocks in stream, a little east of Ardpattan Lough, three miles north-east of Ballyshannon; dark gray shale, lower limestone shale.
17	106/2	Kildoney Glebe, .	Rocks on shore, one mile north-east of Kildoney Point, three and a quarter miles north-west of Ballyshannon; gray micaceous sandstone, lower carboniferous.
18	106/4	Finner, .	Quarry in field, close to cliffs, half a mile north of Single-street, Bundoran, three miles south-west of Ballyshannon; dark gray crinoidal limestone and shale, lower limestone.
19	106/4	Do., . .	Rocks on shore, a little south of Aughrus Point, half a mile north of Bundoran Church, four miles south-west of Ballyshannon; dark gray crinoidal limestone and shale, lower limestone shale.
20	106/4	Magheracar, . .	Cliffs on shore, under Rochfort Lodge, one mile west of Bundoran, five miles south-west of Ballyshannon; dark gray crinoidal limestone and shale, lower limestone shale.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
21	106/4	Magheracar, . .	Rocks on shore, a little north-west of Sea-view, about three quarters of a mile north-west of Bundoran Church, four and three quarter miles west of Ballyshannon; dark gray limestone and shale, lower limestone shale.
22	106/4	Finner, . .	Rocks in railway cutting, about one mile north-east of Bundoran Station, three miles south-west of Ballyshannon; dark gray carboniferous limestone.
23	107/1	Abbeylands, . .	Rocks close to Assaroe Abbey, half a mile north-west of Ballyshannon; dark bluish-gray compact limestone.
24	107/1	Sheegys, . .	Rocks on west shore of River Erne, at Abbey Bay, a little north of Whitehall Point, one mile west of Ballyshannon; dark gray shales, lower limestone shale.
25	107/1	Ballymacaward, .	Rocks on shore, one and a half miles south-east of Wardstown House, one and a half miles north-west of Ballyshannon; dark gray limestone, lower limestone.
26	107/1	Do. . .	Rocks on shore, at Pollpatrick, about three quarters of a mile south of Fern Hill Glebe, two and a half miles north-west of Ballyshannon; light gray arenaceous and micaceous limestone, lower limestone.
27	107/1	Ardeelan, Lower, .	Rocks on shore, half a mile north-east of Coolmore, three and a half miles north-west of Ballyshannon; dark gray shale, lower limestone shale.
28	107/1	Creevy, . .	Rocks in field, near Creevy National School, Ballygal, two miles north-west of Ballyshannon; gray, decomposing to yellow, sandstone, lower carboniferous.
29	107/1	Tullymore, . .	Rocks in field, half a mile north-west of Tullymore Bridge, one and three quarter miles north of Ballyshannon; dark gray limestone.
30	107/3	Townparks, . .	Rocks at Assaroe Waterfall, River Erne, a little west of Ballyshannon Bridge; dark gray limestone and shale, lower limestone shale.
31	107/3	Finner, . .	Quarry in field, north of road from Ballyshannon to Bundoran, two miles south-west of Ballyshannon; gray crinoidal limestone.
32	107/3	Dunmuckrum, .	Quarry in field, west side of road from Ballyshannon to Doon Lough, a little north-west of Higginstown House, one mile south of Ballyshannon; gray crystalline limestone.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
33	107/3	Carrick, . .	Rocks on sea shore, a little south-west of Ballyshannon, east of Portnason House; dark gray limestone and shale, lower limestone shale.
34	107/4	Ballyhanna, . .	Rocks at Kathleen's Waterfall, south side of River Erne, a little west of Stoneswold, one mile east of Ballyshannon; dark gray limestone, lower limestone.
		Co. of SLIGO.	
35	2/1-2	Killkilloge, . .	Cliff at Carrickgarve, eight miles west of Bundoran; light gray sandstone, lower carboniferous.
36	3/1-2	Grollagh, . .	Rocks on shore, a little west of the mouth of Bunduff River, two and a half miles west of Tullaghan, four and a half miles south-west of Bundoran; light and dark gray sandy micaceous shale, lower carboniferous.
		Co. of DONEGAL.	SHEET 32.
37	100/1	Golard, . .	Crags in field, about quarter of a mile south-east of Tullybrook, two and three quarter miles south-east of Donegal, and four miles north-east of Ballintra; dark gray limestone, lower limestone.
38	100/3	Carrickbreeny, .	Rocks in stream, one and a half miles north-east of Ballintra, half a mile south-west of Ballinakillew Lough; dark gray shale, lower limestone shale.
39	100/3	Lisnapaste, . .	Road cutting, a little south of Ballinakillew Lough, two miles north-east of Ballintra; dark gray earthy limestone and shale, lower limestone shale.
40	102/2	Tullylark, . .	Quarry at roadside, quarter of a mile south-west of Tullylark Bridge, three miles north-east of Pettigoe; gray crinoidal limestone.
41	104/1	Carrickbreeny, .	Quarry on west bank of Ballintra River, half a mile north of Brownhall, one and a quarter miles north-east of Ballintra; dark gray limestone.
42	104/3	Tober, . .	Rocks on west shore of Lough Golagh, five miles north of Belleek; dark gray crinoidal limestone.
43	104/3	Tober or Ballymagroarty.	Rocks in small stream, quarter of a mile west of Lough Golagh, a little east of National School, five miles north of Belleek; light gray limestone.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
44	105/2	Gortinessy, . .	Quarry on west bank of Termon River, a little south of Lurganboy Bridge, one and a quarter miles north-east of Pettigoe; gray earthy limestone.
45	105/4	Agnahoo Glebe, .	Rocks in railway cutting, one mile south-west of Pettigoe, half a mile north of Waterfoot; gray limestone.
46	107/4	Edenagor, . .	Railway cutting under road, from Ballyshannon to Belleek, one and a quarter miles north-west of Belleek, three miles south-east of Ballyshannon; dark gray compact crinoidal limestone.
47	107/4	Cloghore, . .	Rocks in field, one mile north-west of Belleek, a little south of River Erne; light gray limestone.
48	107/4	Do., . .	Rocks on south bank of River Erne, opposite Cliff Demesne, about one mile north-west of Belleek; dark gray limestone.
		Co. of FERMANAGH.	
49	1/3	Inisclin, . .	Rocks in Termon River, at Inisclin Bridge, about two and a half miles north-east of Pettigoe; dark gray limestone.
50	1/4	Gortnagullion, .	Rocks on side of road, at near Gortnagullion National School, quarter of a mile north of Drummoney Bridge, three miles north of Kesh; ochrey and buff coloured sandstone lower carboniferous.
51	1/4	Montiaghroe, .	Rocks close to stream, a little east of Roman Catholic Chapel, half a mile north-east of Montiaghroe Bridge, four miles north-east of Kesh; arenaceous ochrey limestone, lower carboniferous.
52	4/3	Rossharbour, . .	Rocks in small stream, under railway, at Rossharbour Bay, Lough Erne, three miles north-east of Castlecaldwell, six miles north-east of Belleek; dark gray shale, lower limestone shale.
53	4/4	Dreenan, . .	Rocks on shore, at western end of Boa Island, Lough Erne; light gray micaceous sandstone, decomposing to ochrey, lower carboniferous.
54	4/4	Portnablahy, . .	Rocks on shore, at Black Bay, Lough Erne, about three miles south-west of Pettigoe; dark gray crinoidal limestone.
55	5/2	Skrinny, . .	Rocks in stream, a little south-east of Killygarry Bridge, two miles north-east of Kesh; pale yellow and gray sandstone, micaceous, lower carboniferous.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
56	5/2	Drumkeeran, . .	Rocks in stream, north of Killybarry Bridge, about two and a half miles north-east of Kesh; dark gray limestone and shales, lower limestone shale.
57	5/2	Tubbrid, . .	Rocks on road, at Charter Schoolhouse and Church, about two miles north of Kesh; gray and ochrey calcareous sandstone, lower carboniferous.
58	5/2	Aghagrefin, . .	Old quarry in field, quarter of a mile south-west of Killygarry Bridge, one and three quarter miles north-east of Kesh; gray micaceous sandstone.
59	5/4	Mullaghmore, .	Rocks in Kesh River, close to road, one mile east north-east of Kesh; dark gray limestone.
60	8/1	Rathmore, . .	Drainage excavations, at Belleek Island, a little south of Belleek; dark gray limestone.
61	8/1	Commons, . .	Old quarry, one mile north-east of Belleek, on side of road to Castle Caldwell, close to county boundary; dark gray limestone.
62	8/2	Keenaghan, . .	Quarry at side of road, from Belleek to Castlecaldwell, two miles north-east of Belleek; dark gray limestone.
63	8/2	Druminillar, . .	Rocks in field, about a quarter of a mile west of Magheramenagh Castle, two miles east of Belleek; dark gray compact limestone.
64	8/2	Tieveolough Glebe,	Old quarry, south side of Keenaghan Lough, close to Abbey, about two and a quarter miles north-east of Belleek; dark gray limestone and shales, lower limestone shale.
65	8/2	Ballaghee, . .	Small quarry in field, about half a mile north-east of Magheramena Castle, close to road from Belleek to Castlecaldwell, about two and three quarter miles north-east of Belleek; light gray limestone.
66	8/2	Ferny, . .	Rocks on east shore of Ferny Island, Lough Erne, four miles east of Belleek; dark gray and dove coloured limestone, crinoidal and pisolitic.
67	8/2	Tirigannon, . .	Rocks in lane, quarter of a mile west of Castlecaldwell Church; dove coloured compact limestone.
68	8/2	Leggs, . .	Quarry in field, near Castlecaldwell Church, four miles north-east of Belleek; light bluish limestone.

LOCALITIES from which FOSSILS were collected—*continued.*

No. of Locality.	Quarter Sheet of 6-inch Map.	County and Townland.	Situation, Geological Formation, and Sheet of 1-inch Map.
69	9/1	Rossbeg, . .	Rocks on south shore, Bleanalung Bay, half a mile north-east of Castlecaldwell; dark gray limestone and shale, lower limestone shale.
70	9/1	Do., . .	Rocks on north shore of Rossmore Bay, half a mile east of Castlecaldwell; dark gray limestone.
71	9/2	Muckinish, . .	Rocks on north shore of Muckinish Island, Lough Erne, one mile south of Castlecaldwell Church; dark gray crinoidal and pisolitic limestone, and buff coloured sandstone, lower carboniferous.
72	9/4	Shean, . .	Rocks in stream, a little south of Churchill-road, nine miles east of Belleek; dark gray earthy limestone and shale, lower limestone shale.

LIST of the FOSSILS collected at the LOCALITIES mentioned in the preceding TABLE.

The numbers opposite each species refer to the places at which they were collected and the × placed before some of them is intended to denote their comparative abundance.

CARBONIFEROUS LIMESTONE, SHALE, AND SANDSTONE.

PLANTÆ.

	Localities.
Sagenaria veltheimiana, ...	2, 3A,* 17.
" " longitudinally striated stems (3½ inches in diameter), ...	3.
Plants, probably roots of S. Veltheimiana, longitudinally striated, ...	1B, 2, 3A, × × 17.
Filicites linearis? branching, ...	1, 50, 56, 57, 58.
Plant stem? Sigillaria, ...	18.
" remains, ...	3A, 28.

ACTIONOZOA: *Corals.*

Amplexus coralloides, ...	65.
Chætetes tumidus, ...	1B, 3, 15, 24, × × 56, 72.
Cyathophyllum ceratites, ...	16, 19, × × × 20, × 21, 25, 27, 32, 38, 44, 64.
" (Zaphrentis) cylindrica, . .	× × 1B, 3, 16, × × × 20, 21, 24, 32, 49, &c.
" or Zaphrentis, small turbinated corals, ...	1B, 3, 16, 21, × 24, 25, 29, 31, &c.

* In reference to this locality, the so termed "Fossil Tree," with attached roots, was discovered by Mr. Ryland Byron, in 1855. This very interesting Fossil was presented to the Museum of the Royal Dublin Society by Sir Richard Griffith; the diameter of its trunk being over 1 foot 6 inches, from which four roots proceed. They measure over 1 foot across and 2 feet to where they branch, both trunk and roots so far as they are preserved being strongly ridged longitudinally.

	Localities.
Favosites parasitica,	1B, 3, 4, 20, 64.
Lithodendron affinie,	3, × × × 21, 49, 56, 59.
„ junceum,	3, 4, × × × 21, × 24, 25, 60.
Michelinia favosa,	× × × 1A, × × 3, 18, 37, 44, 49, 59.
Syringopora geniculata,	× × 3.
„ „ small var. (ramulosa),	47.
„ reticulata,	1B.
Zaphrentis Enniskilleni,	21.

ECHINODERMATA: *Echinoidea.*

Archæocidaris Urii, or vetusta,	1B, 3, 20, 21, 24.
„ vetusta,	20, 21.
Palæchinus elegans,	× × × 3, 15, 20, 38, 63.
„ gigas,	3, 7.

Crinoidea.

Actinocrinus lævis,	4, 8, 15, × × × 19, 20, 21, 23, 24, 27, × × × 30, &c.
„ polydactylus,	19.
„ triacontadactylus,	6, 31.
„ sp. indet,	6, 14.
Cyathocrinus planus,	3, 18.
Platycrinus lævis,	14, 19, 21.
„ rugosus,	12, 20.
Poteriocrinus crassus,	18, 19, 20, 21, 24, 29.
„ lævis,	20.
Crinoid fragments,	Passim.

ANNELIDA.

Serpula hexicarnata,	37.
„ parallela,	× × 3.
Sea worm? (burrow of),	3.
Molluscan? (track),	39.

CRUSTACEA: *Phyllopoda.*

Dithyrocaris, sp.,	38.

Ostracoda.

Leperditia Okeni,	10, 15, × × 20, × 22, 38, 39, 42, 44, 64, 65.
Entomoconchus Scouleri,	64, 65.

Trilobita.

Griffithides globiceps,	15, 67.
Phillipsia Brongniarti,	41.
„ Colei,	× × × 38, 39.
„ Derbiensis,	4, 10, 14, 15, 19, 27, 46, 70.
„ pustulata,	4, × 5, 6, 10, 15, × × × 16, 19, 38, 43, 45, × × 64.

POLYZOA.

Ceriopora interoposa,	21, 52.
„ rhombifera,	14.
Fenestella antiqua (plebeia M'Coy),	1B, 3, 14, 15, 16, × × × 19, × 20, and numerous other localities.
„ crassa,	19, 21.
„ ejuncida,	× 72.
„ frutex,	43.
„ membranacea,	31.
„ Morrisii,	65.
„ tenuifila,	16, 19, 21, 24, 63, 64.
„ undulata,	72.
„ verrucosa,	39, 63, 65.

	Localities
Glauconome bipinnata,	24, 67
„ pluma,	27.
Ptylopora flustriformis,	31, 64.
Vincularia dichotoma,	××63, 65.

BRACHIOPODA.

Athyris ambigua,	1B, 27, 65, 67.
„ planosulcata,	3, 4, 6, 10, 11, ××14, ×15, 16, and abundant at numerous other localities.
„ Royssii,	3, 10, 14, 16, 19, ××24, ×27, &c.
Chonetes comoides,	32.
„ Hardrensis,	8, 9, 14, 21, 24, 27, &c.
„ papilionacea,	19, 24, 29, 54.
„ sarcinula,	21, 65.
Cyrtina carbonaria (Pentamerus M'Coy),	50.
Discina nitida,	20, 21, 65.
Léptagonia plicatilis,	8, 10, 12, 19, ×21, &c.
Orthis Michelini,	3, 4, 5, 6, 14, ×16, ×19, ×24, &c., &c.
„ resupinata,	4, 8, 16, 18, ××19, 21, 24, and numerous other localities.
Productus aculeatus,	15, 20, 22, 45, ××46, &c.
„ fimbriatus,	34.
„ giganteus,	×××1A, 3, 11, 12, ×15, &c., &c.
„ margaritaceus,	8, 24, 31, 48, 60.
„ mesolobus,	63, 65.
„ punctatus,	3, ××9, 11, ×13, 15, 18, ××19, and numerous other localities.
„ pustulosus,	61.
„ scabriculus,	Passim.
„ semireticulatus,	„
„ undatus,	„
Rhynchonella pleurodon,	1, 1B, 3, ××6, 14, 15, 16, ×19, &c.
„ pugnus,	68.
Spirifera bisulcata,	18, 21, 24, ×25, 48, 63, 65.
„ cuspidata,	40, 64.
„ glabra,	63, 64, ××65, 68.
„ laminosa,	1B, 5, 14, 15, 19, 24, 63.
„ lineata,	6, 15, 65, 68.
„ striata,	3, 4, 12, 14, ××19, ××21, 24, and numerous other localities.
„ „ var. Mosquensis,	65, 67.
Spiriferina cristata,	15, 21.
Streptorhynchus crenistria,	Passim.
Terebratula hastata,	20, 25, 26, 42, ×43, &c.

MOLLUSCA: *Lamellibranchiata.*

Avicula lunulata,	25.
Aviculapecten alternatus,	×50.
„ arenosus,	1, 19, 20, 24, 51, 52, 64.
„ concentricostriatus,	10, 21, 24, 52.
„ dissimilis,	11.
„ granosus,	15, 25.
„ hemisphæricus,	69.
„ interstitialis,	16.
„ lævigatus,	? 50.
„ plicatus,	20, 24, 27, 28.
„ priscus,	25, ? 53.
„ Sowerbyi,	××6, 10, 20, 25, 27, 48,
„ tessellatus,	65.
„ sp. indet,	1, 1B, 2, 20, 24, 27.
Axinus axiniformis,	28.
„ deltoideus,	20, 28
„ (Anatina) obliquus,	20, 57.
Byssoarca lanecolata?	38.
Cardiomorpha oblonga,	65.
Cypricardia sinuata,	25, ? 57.

	Localities.
Cyprina ? Egertoni,	32.
Dolabra sp.,	20, 51, 54, 56.
Edmondia gibbosa,	20.
„ oblonga,	20.
„ obsoleta,	20, 21, ? 53, 66
„ prisca,	20.
„ quadrata,	20, 21.
„ sulcata,	20, 21.
„ sp.,	11, 21.
Leda attenuata,	20.
„ clavata,	20.
„ sp.,	27.
Lucina ? antiqua,	16.
Mactra ? ovata,	56.
Modiola Macadami,	64, 66.
„ patula, ? granulosa Ph.,	32.
Modiolopsis ? Brycei,	32.
Myacites tumida	20.
„ sp.,	25, 27, 48, 66.
Myalina Verneuilii,	50.
„ gryphus,	50, 53, 55, 56.
Pinna affinis,	20.
„ flabelliformis,	20.
„ flexicostata,	21.
Pleurorhynchus aliformis,	43.
„ fusiformis,	×3, ××19.
„ Hibernicus,	60.
„ rostratus,	43.
Posidonomya vetusta,	? 27.
Pterinea sp.,	4, 20.
Pullastra ? bistriata,	14, 15.
„ ? scalaris,	39, 41.
Sanguinolites angustatus,	16.
„ attenuatus,	25, 53
„ discors,	20.
„ plicatus,	5, ××20, 21, 24, 28, 36, 37, 41.
„ tricostatus,	56.
Solenopsis pelagicus,	20.
Small obscure bivalves,	1, 15, 16, 20, 23, 25, 26, 28, 34, and at various other localities.

Gasteropoda.

Euomphalus acutus,	4.
„ carbonarius,	7.
„ catillus,	24.
„ crotolostomus,	15, 29, 64.
„ Dionysii,	××18, 45.
„ pentangulatus,	63, 65.
„ pileopsideus,	3, 4, 19, 20, 36, 43, 46, 47, 54.
„ planorbis,	43.
„ plicatus,	24.
„ serpuloides,	3, 20.
„ sp. indet.,	20, 32, 40, 66.
Loxonema Lefebrei,	19.
„ (Turritella M'Coy) megaspira,	16, 46.
„ sp.,	11, 16, ×20, 25, 34, 43, 64.
Macrocheilus (Turbo M'Coy) spiratus,	43.
„ sp.,	20.
Natica elliptica,	43, 61.
„ plicistria,	11, 12, 20, 22, 37, 47.
„ sp.,	20, 25, 26.
Pleurotomaria abdita,	40.
„ sp.,	20, 27.
Univalves indeterminable,	1, 16, 20, 26.

Heteropoda.

Bellerophon apertus,	? 1, 1B, 3, ? 18, 42, ? 47.
„ sp.,	11, 53.
Porcellia Puzosianus,	19.

Cephalopoda.	Localities.
Goniatites crenistria,	54.
,, mutabilis,	? 38.
Nautilus biangulatus,	65.
,, bisulcatus,	48.
,, tetragonus,	53.
,, (Discites) sp.,	10.
Orthoceras Goldfussianum,	20.
,, inæquiseptum,	45.
,, Steinhauerii,	16, 27, ? 64, 72.
,, sp.,	12, 15, 20, 25, 28 31, 38, 64, 65.

VERTEBRATA: *Pisces.*	
Cladodus mirabilis,	53.
Cochliodus contortus,	64.
,, deltoideus,	1.
Deltodus sublævis,	43.
,, sp.,	64.
Helodus gibberulus?	20.
,, lævissimus,	64.
,, sp.,	3, 19.*
Palæoniscus sp., Fin ray,	19.*
,, ,, spine (Ichthyodorulite),	19.*
Psammodus porosus,	19.*
,, rugosus,	3.
,, ? fish bone,	24.

REMARKS ON THE FOSSILS.

Nearly 2,000 fossils were collected and examined from seventy-five localities in the one-inch sheets of the map, besides numerous others observed and recorded at the various places visited by myself and Mr. Clark. The lowest fossiliferous beds observed by us were dark gray micaceous shales and sandstones, with plant remains only; immediately upon these are superimposed dark, almost black shales, and earthy limestones, containing a profusion of fossils, indicating that division of the Carboniferous series designated as "Lower Carboniferous shale." Strata of this character may be well observed in the cliffs and rocks on the sea coast of this district, from Muckross Point (Sheet 30, loc. 1) to the cliffs a few miles west of Bundoran; the dark gray micaceous and arenaceous strata, with remains of large plants only, appearing at a comparatively few places, viz., localities 1, 1 B, 2, 3 A, 17, 18, 28, 36 (8 localities). At a few other places, and in more arenaceous strata, plant remains were found, associated with casts of shells, principally *Brachiopoda*, and *Crinoid* joints; these plants were small and branching, resembling *Filicites linearis*, so abundant in the Lower Carboniferous shales of the County of Cork, &c. At the (exclusively) plant localities first mentioned, the remains observed were longitudinally striated stems, sometimes being as much as 3½ inches in diameter; these I have referred to *Sagenaria Veltheimiana*. They closely resemble those of Tallow Bridge, Co. Waterford, and Hook Head, Co. Wexford, where the passage beds of Lower Carboniferous strata into what is called "Devonian, or Old Red Sandstone" is described by the Rev. Dr. Haughton.† Subsequently to

* De Montmorency Collection.

† "On the evidence afforded by Fossil Plants as to the boundary line between the Devonian and Carboniferous Rocks."—Journ. Geol. Soc., Dublin, Vol. VI., p. 227, &c.

this paper by Dr. Haughton a communication was made to the same Society by Robert H. Scott, C.E.* In this paper he states that "Griffith's map shows the whole of St. John's Point as Carboniferous, excepting a small belt at the extreme end,† where the lower limestone appears, the junction of sandstone and limestone being quite conformable"; . . . "passing M'Swyne's Castle traces of plants are in great abundance in this sandstone." "Dorney Point (a mile north of Castle Point), about this locality *Stigmariæ* occur in great abundance; the fossil tree, which Mr. Byron discovered last year (1855), and which is in the Museum of the Dublin Society, was found near a trap dyke at this place." "Close to Shalwy shore (west side of Fintragh Bay) are yellowish shales with *Stigmariæ* scattered through it." "We observed sandstone similar to that of Dunkineely, and as full of fossils, at Mount Charles, near Donegal"—(1 inch Sheet 23). Prof. Haughton, in discussion, "considered that Mr. Scotthad clearly established the position of these northern beds (as in the south of Ireland), as immediately overlying the Old Red conglomerate, and therefore Carboniferous."

In Vol. IX of the same Journal, a second paper on this subject is communicated by Dr. Haughton.‡ In this paper he describes and figures an extremely doubtful organism, as a plant, under the name of *Dictyophyllum Darniense*, which is most probably the effect of current markings on the ancient sandy shore. He also alludes to other fossil plants "bearing a striking resemblance to *Lepidodendron Griffithii* found at Kiltorcan." This fossil has since been referred by me to *Sagenaria Veltheimiana*, but the late Dr. Schimper, in his fine work "Traité Palæontologiè Végetale," Vol. II., 1870, Part I., p. 48, figures and describes it and its fruit as a new species under the name of *Knorria* (Sagenaria) *Bailyana*, he having shown the spores, &c., of the fruit to differ essentially from that of *S. Veltheimiana*.§

A second paper by Mr. Scott‖ may be here noticed, as it also refers to the district included in these maps and its immediate neighbourhood. He states, that "the district with fossil plants at Dorney, described by Professor Haughton" (as before quoted) "belongs to the lower part of the Carboniferous system, consisting of sandstones and arenaceous limestone"; and alludes to "plants found at Inver immediately below the town of Mount Charles," which he had received from Wm. Harte, Esq., C.E., county surveyor of Donegal, as "somewhat resembling *Lepidodendron*, in yellow sandstone, and lying distinctly under the Lower Limestone." "The large bivalve shell *Cucullæa Griffithii*" (frequent in Lower Carboniferous shales of the county Cork) "as being found in road stones." He also states, that "in a quarry close to the mill at Mount Charles, Carboniferous mollusca, viz., *Streptorhynchus crenistria*, *Euomphalus calyx* (? *tabulatus*) are associated with the plants, scales of fish, and the palatal tooth of *Psammodus*, probably *P. porosus*; Mr. Baily, to whom the fossils were submitted, considered the plant to be *Sagenaria vel-*

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* "On the Carboniferous Beds of Killybegs, Co. Donegal"; Journ. Geol. Soc., Dub., Vol. VII., p. 181.

† This should more properly have been described as the commencement, east of Dunkineely, of the tongue of land called St. John's Point.

‡ "On some additions to the Yellow Sandstone Flora of Donegal," by the Rev. Samuel Haughton, F.R.S., Journ. Geol. Soc., Dub., Vol. IX., p. 13.

§ The roots of this species, although somewhat resembling the so-called *Stigmaria* of the coal measures, are, I consider, decidedly distinct, as also are the stems, which have been loosely regarded by some writers under the names of *Sigillaria*, *Calamites*, &c., as identical with those of the coal-measures.

‖ "On Fossils of the Yellow Sandstone of Mount Charles, county Donegal," by Robert H. Scott, M.A.—Jour. Geol. Soc., Dub., Vol. X., p. 107

theimiana, the molluscan shells *Cucullæa Griffithii* or *trapezium*, *Avicula Damnoniensis*, and *Streptorhynchus crenistria* (abundant); all these fossils being highly characteristic of Lower Carboniferous strata in the South of Ireland.

The CORALS arranged under ACTINOZOA in the preceding list are few in species at the localities visited, and for the most part indicative of Lower Limestone shale; the turbinated forms *Cyathophyllum* and *Zaphrentis* being most prevalent, whilst *Syringopora geniculata* was observed at some localities in large stools, five and six feet or more in length, particularly at Shalwy Point (loc. 1 A.), and St. John's Point (loc. 3). *Michelinia favosa*, another eminently characteristic Lower Limestone fossil, was seen to be very abundant at loc. 4, and the large turbinated coral *Cyathophyllum* (Zaphrentis) *cylindrica*, measuring 18 inches long by 2½ inches in diameter, in the rocks on shore near Bundoran (locs. 20 and 21), as also at St. John's Point (loc. 3.)

Of ECHINODERMATA, the rarer forms of *Echinoidea*, *Archæocidaris*, and *Palæchinus*, are not uncommon at some of the localities, more especially the latter genus at loc. 3. *Crinoidal* remains in vast abundance occur in the strata considered by me, and the writers referred to, as Lower Limestone shale, being particularly abundant at locs. 1 B., 18, 19, 20, 21, &c.

Most important amongst the CRUSTACEA are *Trilobitæ*, the species most prevalent being *Phillipsia pustulata*, *P. Derbiensis* and *P. Colei*, the latter occurring in considerable number and entire at locality 36.

POLYZOA, as usual in these Lower Carboniferous shales, were found to be abundant, especially *Fenestellæ*; *F. antiqua*, a characteristic species, occurring at 17 localities.

Of BRACHIOPODA, thirty-three species are included in the preceding list, those most widely distributed being *Productus semireticulatus* at 42 localities; *P. punctatus* at 23; *P. scabriculus* at 20; and *P. giganteus* at 18 localities. *Spirifera striata* at 26 localities. *Athyris planosulcata* was observed at 28, and *A. Royssii* at 16 localities; *Streptorhynchus crenistria* at 24 localities; *Orthis resupinata* at 20, and *O. Michelini* at 12 localities: *Chonetes Hardrensis* at 15 localities; *Rhynchonella pleurodon* at 14 localities, and *Terebratula hastata* at 10 localities. Amongst this class of fossils, always so abundant in Carboniferous strata, there are certain species peculiarly characteristic of the lower shales, such as *Orthis Michelini*, *Streptorhynchus crenistria*, and *Chonetes Hardrensis*.

The *Lamellibranchiate* MOLLUSCA—bivalve shells—were found to be numerous in species, but not so abundant in the number of individual specimens; the identified species were about fifty, many of them from arenaceous strata, of these the genus *Aviculopecten* shows the greatest number of species, viz., 12. A large shell belonging to this class, *Pleurorhynchus fusiformis*, to which my attention was first called by Mr. Clark, was observed to occur in isolated groups on the exposed surface of a large bed of earthy limestone on the sea-shore near Aughrus Point, a little north of Bundoran, locality 19, and also at locality 3. The finding of this shell was of especial interest, as indicative of strata of corresponding age, at widely distant places in Ireland; it is of large size, being about four inches in length, by two inches broad; and occurs frequently in strata lithologically and chronologically similar, on the surfaces of certain beds of earthy limestone on the Malahide shore, having frequently bunches of a coral (*Syringopora geniculata*) attached

to it, being also found at Hook Point in similar strata. The small muscle-like shell *Modiola Macadami*, also characteristic of Lower Carboniferous strata, was observed at localities 64 and 66.

Gasteropod Mollusca were comparatively unfrequent at the places examined; the genus *Euomphalus*, of which ten species are included in the list, being that most represented in species; *E. pileopsideus* was noticed at 9 localities, whilst the common species of the Middle Limestone, *E. pentangulatus* was only observed at two places. *Heteropoda* and *Cephalopoda* were found to be still less numerous both in genera and species.

The fish remains consisted almost entirely of palatal teeth, the exceptions being a large tooth of an Hybodont fish, *Cladodus mirabilis*, found in Carb. sandstone at Boa Island, Lough Erne, loc. 51, a spine (*Ichthyodorulite*) and a portion of a fin ray, both doubtfully referred to *Palæoniscus*. The palatal teeth include *Psammodus porosus* from locality 3, St. John's Point, where we collected a specimen measuring $3\frac{3}{4}$ inches by $2\frac{1}{2}$ inches; and *P. rugosus*, from locality 19, Bundoran shore (De Montmorency collection). The other fish palates I have referred to *Cochliodus*, *Deltodus*, and *Helodus*.

WILLIAM HELLIER BAILY.

March 27th, 1888.

PETROGRAPHICAL APPENDIX.

I.—ARCHÆAN ROCKS.—By J. J. H. TEALL, F.R.S.

(For list of localities see p. 10.)

(1.) 527. Medium to fine grained, greyish, banded gneiss. The banding is due to thin layers relatively rich in biotite. The general appearance of the rock in the hand-specimen is that of a banded granulitic gneiss, but under the microscope the general structure is granitic rather than granulitic, the individual constituents having very irregular outlines. The essential constituents are felspar, quartz, biotite, muscovite. The accessory minerals are garnet (abundant), zircon (rare), and apatite (rare). The felspars include microcline, which is very abundant, oligoclase and probably orthoclase. They are irregular in form. Quartz occurs in irregular patches and as granulitic aggregates, the latter usually associated with the former. The irregular patches have an interstitial habit. The biotite occurs in irregular plates of a rich brown colour in transmitted light. Several individuals usually occur together without any regularity as regards orientation. Muscovite is comparatively rare. It is found associated with the biotite and also under conditions which suggest that it is in part a result of the alteration of felspar. Garnet is scattered through the rock in the form of small and generally more or less rounded grains.—*Muscovite-biotite-gneiss.*

(2.) 528. A coarse-grained, pinkish granitic rock of somewhat uneven texture, approaching the character of a pegmatite at one side where there is a large plate of biotite measuring $\frac{3}{4}$ of an inch across. The rock is composed of orthoclase, microcline, oligoclase, and more or less altered biotite. Microcline and micro-pegmatite (rare) occur as interstitial components. Quartz is sometimes idiomorphic with respect to microcline, and so also is orthoclase. The felspars, with the exception of microcline, show the mica-type of decomposition.—*Biotite-granite.*

(2.) 529. A dark crystalline hornblendic rock speckled with small white irregular granulitic aggregates. It possesses a somewhat irregular fracture and there are only faint traces of schistosity. The constituents are hornblende, biotite (scarce), felspar, iron-ores, epidote quartz, and sphene. The hornblende occurs in compact green grains and crystals generally forming aggregates, and also as irregular ragged patches containing grains of quartz. The felspar forms granulitic aggregates. A few small epidote-crystals are associated with the felspar. The individual grains of felspar not unfrequently show triclinic lamellation. Sphene occurs as colourless grains forming aggregates round irregular patches of iron-ore. These complex aggregates of sphene and iron-ore, are sometimes bounded externally by crystallographic planes characteristic of ilmenite. Biotite occurs only as an accessory.—*Epidiorite.*

(3.) 530. A black, crystalline rock of medium grain and massive habit. Similar to the last both in structure and composition.—*Epidiorite.*

(3.) 531. A light coloured, banded, granitoid gneiss composed of quartz, microcline, orthoclase (?) oligoclase and muscovite. Iron-ore occurs as an unimportant accessory. The microcline occurs in allotriomorphic grains and is usually quite fresh; the other felspars being more or less decomposed. The quartz contains inclusions with bubbles. —*Muscovite-gneiss.*

(4.) 532. A fine grained, banded gneiss composed of the same minerals as the preceding specimen with the addition of biotite.—*Muscovite-biotite-gneiss.*

(4.) 533. A dark medium-grained, crystalline rock, composed of garnet, hornblende, omphacite, biotite, felspar, and quartz. Iron-ores and rutile occur as accessories. The constitutents are confusedly intercrystallised and none can be described as definitely idiomorphic. Both hornblende and felspar show uniform orientation over considerable areas although they are much broken up by the other constituents. In composition and structure this rock has decided affinities with the eclogites.—*Felspathic eclogite.*

(4). 534. A black moderately coarse-grained massive rock, composed of hornblende, felspar, quartz, iron ores, and sphene. The hornblende often forms large irregular patches, broken up by inclusions of quartz and felspar.—*Epidiorite.*

(5.) 535. A medium-grained banded gneiss composed of quartz, microcline, orthoclase (?), oligoclase, biotite, and muscovite. Apatite and garnet occur as accessories.—*Muscovite-biotite-gneiss.*

(6.) 556. A fine-grained, banded, granulitic gneiss with pseudo-current-bedding structures. The constituents are the same as in 535. *Mucovite-biotite-gneiss.*

(7.) 537. A moderately coarse-grained, grey granite or granitoid gneiss, composed of orthoclase, microcline, oligoclase, quartz, biotite, and muscovite. Sphene occurs as an accessory and the biotite is sometimes replaced by chlorite. Parallel planes of inclusions may be traced for considerable distances in certain portions of the slide. These are independent of the orientation of individual grains.—*Muscovite-biotite-gneiss.*

(8.) 538. Muscovite-biotite-gneiss; iron-ores unusually abundant in this specimen.

(9.) 539. Granulitic muscovite-biotite-gneiss with strongly marked parallel structure. Epidote and idiomorphic sphene occur as accessories.

(10.) 540. Epidiorite containing much epidote and a little biotite.

(10.) 541. Evenly banded granulitic biotite-gneiss. Contains microcline; biotite often replaced by chlorite.

(11.) 542. Biotite-gneiss. Contains microcline and a few garnets.

(12.) 543. Dense greenish grey felspathic eclogite. This specimen contains more garnet and less felspar than those which have been previously described under the same name.

(13.) 544. A dark green schist, composed of hornblende, biotite, felspar, quartz, epidote, and sphene.—*Hornblende-biotite-schist.*

(14.) 545. A coarse grained grey gneiss having the planes of easy fracture coated with good-sized flakes of white mica. The principal constituents are quartz, microcline, and muscovite. Biotite is also present but not in any quantity. Zircon occurs as an accessory.—*Muscovite-biotite-gneiss.*

(15.) 546. Similar to the last but with much more biotite and a fair amount of garnet.

(16.) 547. A black, fine-grained schist, composed of hornblende, felspar, quartz, epidote, and granular colourless sphene.—*Hornblende-schist.*

(16) 548. A light-coloured, banded, granulitic gneiss. Biotite-gneiss containing garnet, epidote, orthite (?), and sphene. The mineral doubtfully referred to orthite is of a reddish brown colour and forms inclusions or rather kernels in the epidote.

(18) 549. Hornblende-biotite-schist, with fine aggregates of colourless sphene round kernels of iron-ore.

(19) 550. Dense, black, coarse-grained rock, composed of hornblende, felspar, quartz, and garnet, with epidote and sphene as accessories.—*Garnetiferous amphibolite.*

(19) 551. A well banded gneiss composed of alternating dark and light-coloured layers.

The constituents are quartz, felspar (principally oligoclase), and biotite. The dark layers are extremely rich in biotite.

(21) 552. A light-coloured folded gneiss, composed of quartz, felspar, including microcline, oligoclase, and probably orthoclase, muscovite, and iron-ores (scarce).—*Muscovite-gneiss.*

(22) 553. A black schist, composed of biotite, felspar, and quartz. Garnet, iron-ores, epidote, and hornblende occur as accessories.—*Biotite-schist.*

(22) 554. A fine-grained, greyish gneiss, with a well-marked, flaggy type of fracture.

The constituents are quartz, felspar, and biotite. Iron-ores and garnets are also present. The biotite has been more or less changed to chlorite. Parallel structure is well marked in the arrangement of the constituents, especially the biotite.—*Biotite-gneiss.*

(23) 555. Black biotite-schist, similar to 553, but containing lenticles (? deformed pebbles) of granulitic quartz. In the hand specimen the quartz-lenticles sometimes have a blue colour. This rock has affinities with some of the "green schists" in the central and southern Highlands of Scotland.

(24) 556. This rock combines the characters of a gneiss and a phyllite, and may therefore be appropriately termed a phyllite-gneiss. It is composed of quartz, felspar (turbid and undeterminable), white mica, and pyrite. There is a considerable amount of fine opaque dust, which is probably carbonaceous. Micro-flaser structure is well seen in the thin section, the flaser being formed of the mica, and the phacoids of granulitic quartz and the turbid felspar material. The surfaces of the specimen have a lead colour and a strong micaceous lustre.

The rock is, doubtless, of sedimentary origin.

II.—Olivine-basalts and Olivine-dolerites. By J. S. Hyland, ph.d.

The description to be given of these rocks is based upon specimens collected from the following localities :—

Sheet 31.
- Burnfoot, one mile S.W. of Salthill, Doorin Point;
- Shore, 1¼ miles S.W. of Salthill, Doorin Point;
- Shore, a little South of preceding locality, called "Blind Rock" upon Map.

Sheet 32.
- Ballynakillew, 2 miles N.E. of Ballintra;
- A little N. of Shinnan Hill, 4 miles E. of Ballintra;
- A cross-road, nearly ¼ mile North of Inischin Bridge;
- Road, ½ mile N. of Inischin Bridge, 3 miles N.E. Pettigo;
- ¼ mile S.E. of Grouse Lodge, 5 miles N.E. Pettigo;
- 1 mile N.W. of Tullylark Bridge, 4 miles N. of Pettigo.

The fine-grained and compact specimens are to be called olivine-basalts; the fairly coarse olivine-dolerites. As the mineralogical constitution and microscopic structure is the same in both cases, it seems advisable to describe them in the one section. The two dykes at Burnfoot, 1 mile S.W. of Salthill, and on shore 1¼ miles S.W. of Salthill, Doorin Point (Sheet 31), contain curious spherical patches, which will, however, be referred to in detail when their microscopic characters are discussed.

In thin section, under the microscope, the augite mostly appears in irregular plates and rounded grains. In colour it is pale brown, often with a yellowish tinge. It is, at times, very full of gas-pores. Lath-shaped crystals of felspar are found piercing the augitic plates in all directions, and are often completely enclosed by the mineral. This demonstrates the important fact that the formation of the felspar preceded that of the augite. The structure thus produced is the ophitic, and is one highly characteristic of rocks of this class. In some of these rocks considerable movement, prior to consolidation, seems to have occurred, and a decided fluidal-structure is apparent. The olivine rarely shows good crystalline outline; but is mostly present in rounded grains of varying size. Its inclusions are the usually observed ones, and hence call for no special description. It is often completely decomposed into an ochreous, brownish-yellow substance, very similar in appearance to the mineral-product called Hullite, and analysed by Hardman.* Partial decomposition of the olivine into a greenish substance is not frequent. This substance is probably the ochreous material in another stage of oxydation.

The felspar is, as has already been pointed out, lath-shaped in form. Twinning according to the albitic character is always apparent. Star-like aggregates are not uncommonly observed. Generally the felspar lathes are of small size, but occasionally a solitary individual will reach such proportions as almost to put on a porphyritic character. The felspar is at times very rich in vitreous matter, which generally lies

* "Nature," 1878, vol. XVIII., p. 507.

along the twinning plane, and which represents portions of the residual magma in an advanced state of devitrification.

Magnetite grains are frequently encountered, but apatite is rarely to be seen. The dyke across road nearly quarter of a mile north Inisclin Bridge (Sheet 32), contains zeolites, which in microscopic aspect and other characters have some similarity with Phillipsite and Naliorite.

With but few exceptions these rocks contain a varying quantity of interstitial matter. This consists of an indistinct brownish granular substance, rods and bars of magnetite, feathery microlites of felspar, and some acicular microlites not capable of more precise definition or determination.

We now come to the discussion of the peculiar spherical patches of which mention has already been made. These spheres sometimes attain in diameter one quarter of an inch. They consist, as a rule, of yellowish chalcedonic-looking material, with a varying quantity of calcite. Less frequently the half of a sphere will consist of interstitial matter in the condition described above. The spheres are vesicular cavities, the development of which displaced the lath-shaped felspars, for these are either tangentially disposed with reference to them, or are bent round them. The patches are similar to those described by J. J. H. Teall as occurring in the Teignmouth dyke* and regarded by him as gas bubbles, which were produced after the formation of the felspars but before the consolidation of the interstitial matter. Their development he ascribes to the relief of pressure consequent upon the rise of the semi-liquid mass towards the surface, their mode of formation being therefore analogous to the bubbles which arise in the contents of a soda-water bottle as the cork is partially removed. Owing to the absorption, escape, or condensation of the gas in these bubbles, a portion of the mass, which was liquid at the time of their formation, oozed into the vesicles, the part remaining empty after final consolidation being subsequently filled up with chalcedony and carbonates. Those cavities which remained wholly empty were completely filled out with similar material.

At a point upon the shores of Lough Erne, situated about half a mile east of Rossharbour Bay, there is a dolerite dyke which is remarkable in that it contains numerous angular pieces of quartzite. Sections cut from the included fragments show that the liquid mass has forced its way into the quartzite, and has, so to say, saturated it with basic materials. The portions of the dolerite magma have crystallized as brownish masses, in which are found minute felspar-microlites, some magnetite, and a quantity of weakly polarizing substance, the exact nature of which cannot be ascertained. Sometimes the mass is distinctly radiate or spherulitic in character.

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* "On the Amygdaloids of the Teignmouth Dyke."—Geol. Mag., III., Vol. VI., 1889, 481-483.

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